TITLE: " Steering and/or stabilising device for motorised watercraft "

DESCRIPTION

BACKGROUND OF THE INVENTION

1. Field of the invention.

The invention relates to steering and/or stabilising device for motorised watercraft with at least two operating units comprising each a retractable steering and/or stabilising fin.

A motorised watercraft requires a steering device which is not only prompt, precise and light but also offers a minimal resistance to forward movement in the water.

The invention is based on the fact that any watercraft having a completely symmetrical keel and with balanced propulsive forces tends to keep a constant course when sailing if no extraneous forces such as wind, wave motion, current etc. intervene to change the direction of navigation. This is particularly true for fast motorised watercrafts with modern hulls having deep, V-shaped keel

Studies and trials have been carried out on steering devices having two operating units, each comprising a retractable fin and fitted outside the stern of the watercraft in symmetrical positions, one to the starboard side and the other to the port side, these steering fins being kept out of the water during navigation on course and being inserted alternatively and for different extents into the water on the starboard side or on the port side, only when a change of course is required.

2. Description of the Prior Art.

A steering device of this type is known from the document EP 0518229 A1. Each unit of this known device comprises a steering fin attached on the outside of the transom and swinging up and down. A operating unit of this kind is showed in Fig. 1 of the accompanying drawings, in which the swinging steering fin mounted outside of the transom T is indicated with 2 and is actuated by a cylinder 1 located as well outside of the transom T.

This known kind of steering device yielded highly favourable results in trials, in which it was confirmed that a watercraft navigating without rudders showed no

greater instability in maintaining a course than a watercraft provided with conventional rudders, and indeed revealed that steering fins immersed alternatively and for variable extents on the starboard side and on the port side, provided course maintaining and manoeuvring characteristics which were clearly not inferior to those of the conventional rudder systems, with the considerable advantage of causing no resistance to forward movement when the steering fins are retracted during on a constant course.

The known steering device of this kind was not generally applied because of the marked tendency to conservatism characteristic of marine design in general and because of the problems arising from the particular type of steering fins attached on the outside of the transom and projecting from the transom in an area which is normally used for bathing, particularly in leisure vessels. It was also feared that any collision with a quay when backing might damage the integrity of the steering means.

A known stabilising device of the kind mentioned above for motorised watercraft comprises two operating units located preferably in the middle zone of the watercraft, one to the starboard side and the other to the port side and the respective stabilising fins project in the water, placed transversely to the side.

The stabilising fins now known generate forces capable to oppose rolling effect opportunely rotating on a shaft similarly to the conventional rudders. The complicate system of the rotation does not permit except for large watercraft or for ship the possibility to be retractable when the stabilising effect of the fins is not required. This property of the known fins does not permit its application on small or medium size watercraft particularly if fast or planning because the of the excessive resistance in the forward advancement in the water.

SUMMARY OF THE INVENTION

It is an object of the present invention to provide a steering and/or stabilising device for motorised watercraft, with at least two operating units comprising each a retractable steering and/or stabilising fin of the aforementioned general type and according to the pre-characterizing part of claim 1, which device has a simple construction, occupies a minimum space, has a limited weight and a low cost and a

simple and easily manoeuvrable actuating system and above all is practical and reliable.

The invention aims also to provide a steering device of this kind, whose steering fins project predominantly and preferably under the keel, rather than on the outside behind the transom, for reasons of practicality, appearance and safety and above all for functional reasons, in order to operate in a region where the water pressure is greater and in such a way as to prevent the occurrence of cavitations or airing phenomena such as those which may occur with a known steering blade or rudder inserted into open water, and keeping completely free the outside of the transom.

These problems are solved according to the invention by a steering and/or stabilising device for motorised watercraft with at least two operating units located one on the starboard side and the other one on the port side in a transversal plane of the watercraft and comprising each a rectractable fin, this device being characterised in that the fin of each operating unit is contained in a watertight tubular casing open on the bottom or on the underwater portion of the hull sides and located completely or for its prevailing portion inboard, i.e. inside the hull, each fin being guided to slide axially in the associated tubular casing und being movable by manually or by power assisted actuator outwards and inwards in the casing, so that it can be retracted in the casing or projected out of the hull for a variable extent.

When using the device according to the invention as a steering device, the tubular casings of the operating unites are located in the stern zone of the hull and have a pit-like form, being substantially vertical or inclined on the bottom and in a transversal plane the watercraft. The actuators of the operating units are interconnected und manoeuvrable so that the respective fins can be retracted during sailing on course or projected individually and alternatively or for different extent in the water on one side or the other, thus acting as steering fins.

When using the device according to the invention as a stabilising device, the tubular casings of the operating units, oriented preferably horizontally, are also located symmetrically and both lying in a transversal plane preferably in the middle

section of the watercraft or whatever lying between the middle and the stern.

The actuators of the operating units are interconnected und manoeuvrable so that the respective fins can be retracted during sailing in calm water or projected in the water totally or partially on one side or on the other one during sailing in rough seas, thus acting as stabilising fins to oppose the effect of the roll.

BRIEF DESCRIPTION OF THE DRAWINGS

The objects and advantages of the present invention will appear more clearly from the following specification in conjunction with the accompanying schematic drawings, in which:

Fig. 1 is a perspective view of an steering device unit according to the state of the art.

Fig. 2 is an exploded perspective view of the main components of a steering device unit according to the invention.

Fig. 3 is a perspective view of the assembled steering device unit according to Fig. 2.

Fig. 4 is a perspective view of the base flange of the steering device unit according to Figs. 2 and 3.

Fig. 5 is a vertical section of the steering device unit according to Figs. 2, 3 and 4.

Fig. 6 is the control circuit diagram of the actuating cylinders according to Figs.7 and 8.

Figs. 7 and 8 are vertical longitudinal sections of two of the actuating cylinders of the steering device unit.

Figs. 9 and 10 are schematic transversal sections through the hull of a watercraft showing various orientation of the operating units of a steering device according to Figs. 2 to 5.

Fig. 11 is a schematic plan view of the couple of units of a steering device shown in the fig. 9 as transversal section

Figs. 12 is a schematic plan view in middle section, or alternatively in a

section placed between middle and stern of watercraft, of a motorised watercraft provided with two side units of a stabilising device according to the invention.

Fig. 13 is a fragmentary transversal section through the hull of a watercraft showing a preferable orientation of a stabilising device unit.

In Figures 2 to 11 of the drawings a preferred embodiment of an unit of a steering device for motorised watercraft according to the invention is illustrated.

With reference to the drawings, and with particular reference to Figures 9 and 10, the steering device according to the invention has a pair of units U located in the stern zone of the watercraft one on the starboard side and the other on the port side.

The parts of the hull of a motorised watercraft are indicated by: T is the transom, B is the keel, S is the side and U is a steering unit of the steering device according to the invention.

Fig. 2 is an exploded perspective view of the three main parts making up each unit U of a steering device for watercraft according to the invention, shown in the pre-assembly position, while the complete steering unit is also shown in an axonometric view in Fig. 5, which relates to the starboard side embodiment, the other one unit being a mirror image of the latter.

Each unit of the steering device is provided with a movable fin, referred to in a general way as a blade, indicated by the number 4 in the drawings. This blade is sliding vertically in the tubular watertight pit-like casing 5 which is fitted essentially inboard, and has a cross section which is preferably square, rectangular or at least prismatic, in order to withstand the stresses due to the action of the water.

The blade 4 is also connected directly to a box-like guide structure 6 open at its top and is closed at its base where the blade 4 is connected. The cross section of the guide box 6 is similar to that of the casing 5 but on a scale reduced sufficiently to permit the interposition of suitable anti-friction means 13.

The blade 4 can be connected to the guide box 6 by means of bolts or another system, but can also be formed in one piece with the guide box 6, by casting for example. The guide box 6 can also have apertures or holes for lightening if required.

The blade 4 has a special shape in connection to the speed and

characteristics of the watercraft and is designed according to hydrodynamic profiles similar to hydrofoil wings, which are markedly different from those of a conventional rudder for which the essential condition is that it should have a symmetrical profile, since it operates alternatively on both surfaces.

For example, in the case of watercrafts which are not particularly fast, a "roofing tile" concave profile can be used, the blade profile being similar to a circular sector, and then being gradually reduced in width towards the end and twisted to initiate the manoeuvre with an angle of attack of a few degrees and subsequently reaching an inclination of 45°-50°. On the other hand, in the case of high-speed watercraft, an anti-cavitation profile can be used with an eventual helical configuration.

In any case, it should be noted that such experimentation is particularly facilitated by the fact that the blade being tested can be changed directly inboard.

Finally, the blade 4 can be made from any sufficiently strong material, such as bronze, stainless steel, titanium alloy or the like, provided that it is compatible with the hull material and suitable in respect of galvanic corrosion.

Each casing 5 is provided with a suitable flange 7 at its base so that it can be securely fixed to the bottom of the hull, and with a flange 8 at the top to receive a watertight cover 9.

The flange 7 is constructed as indicated in Fig. 4 and is practically closed except for the presence of a slot 41 through which the blade 4 can pass during its downward and upward movement. This slot 41 matches to a slot formed in the bottom of the hull. The slot leaves a clearance around the blade 4 which is barely sufficient to allow the water to flow out of and into the casing during the manoeuvres. The profile of the slot 41 corresponds to the profile of the blade 4.

The casing 5 can economically be formed from a drawn square or rectangular stainless steel section, in a similar way to the guide box 6. If the casing is required to be particularly light, it can be formed by casting from titanium alloy, or can be formed by a robust metal guide frame inserted in a protective structure made from glass-fibre reinforced plastic.

Each unit U of the steering device is provided with an actuator 10 consisting

mainly of a double-acting hydraulic cylinder, whose rod 11 is connected to the base of the guide box 6 to provide the vertical movement of the blade 4 together with its guide 6. The actuator 10 is fitted directly or by means of a flange 12 to the cover 9 of the casing 5. The cover 9 is fixed on an upper flange 8 of the casing 5.

An anti-friction means 13, made in a similar way to that which is normally interposed between the sliding telescopic jibs of a crane, is interposed between the guide box 6 and the casing 5.

In particular, there are provided cleats or strips of anti-friction material 13, mainly fitted on the outer walls of the guide box 6, capable of withstanding the reaction forces and having a low coefficient of friction. They must not have hygroscopic properties, in other words must not swell when exposed to water for long periods.

Many kinds of these strips are available on the market at present.

The anti-friction strips 13 are kept in position as shown in Fig. 5 by means of countersunk-head captive screws 14 and thinner metal strips 15, fitted above and below the said strips 13 to the guide box 6 by the method used for crane jibs.

Figures 7 and 8 show two versions 10a and 10b of the actuating cylinder. They differ from each other in that the version of Fig. 7 is an ordinary double-acting cylinder with a single wall 16 and with inlet ports 37 and 38 located at the two ends of the said wall 16. In this case, the cylinder 10b projects practically entirely above the cover 9 of the casing 5. The version 10a, according to the invention is shown in Fig. 8. According to this embodiment, the cylinder 10a is provided with an outer wall 19 and with an inner wall 20 positioned in such a way that the supply to the lower chamber of the cylinder passes into the gap 21 formed between the outer and the inner walls 19, 20 and enters the lower chamber of the cylinder through holes 18 formed in the base of the lower chamber, with the advantage that the two inlet connections 37 and 38 are both located on the top of the cylinder 10a. With this version, therefore, most of the cylinder 10a can be housed in the guide box 6, thus providing the advantage of a smaller height of the steering unit.

An important and original characteristic of the steering device according to the

invention is the type of connection provided between the rod 11 of the actuating cylinder 10 and the guide box 6, which is fixed to the blade 4. The slidability of the guide box 6 within the casing 5 has to be ensured in all cases for the correct operation of the steering device, and for this purpose a clearance of a certain amount, must be provided, according to the size of the system, machining not generally being specified for the casing 5 or the box 6. For this purpose, the rod 11 of the actuating cylinder 10 must be capable of transmitting the movement to the guide box 6 without transversal stress on the said rod. Therefore, the rod 11 of the cylinder is provided at its lower end with a strong disc 25, as shown in Fig. 5, which is contained between the top 125 of the blade 4 and the base 106 of the box 6, and is radially movable. The rod 11 of the cylinder passes with a sufficient radial clearance through a hole in the base 106 of the box 6 for allowing the radial motion of the said disc 25. The blade 4 and the box 6 can freely move transversally to the side 25 and to the rod 11 of the cylinder 10 for being pushed downwards and retracted axially without transmitting horizontal forces to the cylinder rod 11.

Another characteristic of the steering device according to the invention is the type of hydraulic system used for the remote control shown in Fig. 6, which relates to an installation provided with a reversible manual pump 30 with conventional accessories, shown in the frame 26, and comprising a reservoir 301, a reservoir intake and return valve 302, and a double controlled non-return valve 303 acting as a blocking device. The system 26 can be replaced by any other type of conventional servo-assisted hydraulic system for rudder operation.

In both cases, however, the remote control installation must be provided with sequence valves to prevent the actuation of one blade 4 if the other one has not been retracted.

Suitable sequence valves for this purpose are available on the market, and are generally controlled by the rise in pressure in the chamber of the hydraulic cylinder 10a as the end of the stroke is reached, but for greater safety the invention preferably provides the use of two special sequence valves 27d and 27s, fitted on the top of the actuating cylinders 10a of the steering units U1 and U2 on the starboard and the port

side respectively as shown in Fig.6. Each of these valves is operated directly by a top extension 28 of the piston 29 of the cylinder 10a of the respective unit U1, U2, when the upper limit of the stroke of the piston 29 has been reached, in other words when the blade 4 has been fully retracted. In this position, the extension 28 of the piston 29 raises the control rod 39 of the sequence valve, thus allowing the passage of oil to supply the cylinder of the opposite steering unit. The operation of these valves is made clearer by the diagram in Fig. 6.

If the shaft of the manual pump 30 is moved in the anti-clockwise direction for example, the oil is sent into the pipe 31 as indicated by the arrows, and, after passing through the conventional lock valve 303, the said oil reaches the inlet 38d of the cylinder 10a of one steering unit U1 on the starboard side. The oil flows from the port 38d through the gap between the two walls of the cylinder, and pushes the piston 29d to the top of the cylinder, thus ensuring that the corresponding blade 4 is completely retracted, while the extension 28d of the piston 29d simultaneously raises the control rod 39d of the valve, thus allowing communication between the ports 33d and 35d and consequently the flow of oil in the pipe 36 connected to the inlet 35s of the cylinder 10a of the other steering unit U2. Consequently the piston 29s of the cylinder 10a of this other steering unit U1 and the corresponding blade 4 are pushed down and the watercraft turns to port as required.

To reverse this manoeuvre, it is simply necessary to turn the shaft of the manual pump 30 in the opposite direction, and all the operations will be repeated in the opposite direction. More particularly, the blade 4 of the steering unit U2 on the port side will initially be retracted and, when permitted by the opening of the respective sequence valve 34s, the blade 4 of the steering unit U1 in the starboard side can be made to move downwards, causing the watercraft to turn in the starboard direction.

The sequence valves 27 are characterised in that the push rods 39 of the shutters extend beyond the covers 271 so that they can be used to close electric limit switches 272 to signal to the helmsman the condition of simultaneous opening of the sequence valves, a condition in which both blades are fully retracted, corresponding

to the central position of the rudder in conventional systems, this signal being of the audible and/or visual type or in the form of a small vibration of the wheel which is perceptible only to the helmsman.

The proposed steering device provides the following particular advantages in addition to the general advantages which have been listed, namely:

- A considerable saving of weight and cost owing to the absence of rudder head, tiller, stuffing box and conventional machinery. Furthermore, a smaller and lighter blade, designed to receive the thrust of water from one side only, can be used with equal effect
- A reduced manoeuvring power requested being all thrust of the water supported by the hull and not by the operator effort or by the mechanical power of the steering gear
- The possibility of convenient standardization of the casings and guides.
- The absence of any kind of stuffing box, since the system is contained in a closed and watertight unit.
- The possibility of extracting the whole blade and corresponding actuator assembly directly into the vessel, since the assembly is contained in the watertight casing with a cover above floating line. This characteristic is also useful because the blade can be replaced with another more efficient one at any time, or can be released from any bodies such as nets, ropes, etc., in which it may become entangled.
- The blade has to be extended only by a very small amount below the keel to keep the watercraft on course, so that the forces on the rudder are very limited and manual control becomes possible even for larger watercraft.
- Another important characteristic is due to the type of actuators used, which are of the double-acting type with a non-passing through rod and therefore with an upper chamber, which is the active chamber, having a larger volume than the lower chamber. In practice if an operating time of 10 seconds, for example, will be required for the total immersion of the blade, the retraction could take place in 5 seconds, since the recovery takes place in half the time because the chamber of the

cylinder has to be filled from the rod end. In practice, the rudder responds more rapidly to the helmsman's command.

- Finally, the two operating units are not interconnected mechanically but only hydraulically as described with reference to Figure 6, and therefore the space between them is completely free, this space being particularly useful in the stern area where a watertight recess can be provided at sea level for housing, for example, a tender or a ladder or even an attractive raft which can be pushed out from the stern for the purposes of bathing. This characteristic is of major importance in the case of catamarans.

DESCRIPTION OF THE RETRACTABLE APPENDAGES USED AS STABILIZERS

The stabilising fins used at the present time essentially consist of rudder blades with their axes preferably horizontal or sub-horizontal, normally placed in the proximity of the middle the watercraft, and provided with the system of control faster and always automatic

It should be borne in mind that, at the present time, non-retractable conventional fins are generally fitted on large displacement watercraft and only in special case on larger ship retractable fins are installed because at present state of the art the system is very complex and highly expensive.

The remarks made concerning conventional rudders, to the effect that they require manoeuvring systems on which some or all of the dynamic forces of the water are discharged, are also applicable to present-day stabilising fins, and therefore it will be easily understood that the retractable appendage units according to the invention can also conveniently be used as stabilising fins, in which case they are positioned with horizontal or sub-horizontal axes , as shown for instance in Figures 12 and 13, whose characteristic of being in all cases retractable and therefore also suitable for fitting to fast motor craft, since they will be used only in rough seas and therefore at lower speeds.

Figures 12 and 13 show how the units fully described previously, and indicated by W in this case, can also be fitted on board for this application. In this case also,

the parts of the hull are indicated by the same symbols, namely T for the transom, B for the bottom of the hull and S for the sides of the watercraft.

The transversal section of the hull represented in fig. 12 could be normally comprised between stern and middle ship.

Clearly, it is not possible to use each unit to reverse the direction of the thrust, and therefore it will be necessary to have at least two units, one on the starboard side and one on the port side, to maintain the stabilization, but on the other hand the advantages will be considerable and practically the same as those listed for the steering means, namely:

- The possibility of sailing with the fins retracted when not in use, even in the case of small units.
- The greater efficiency of the blades, which are designed to receive the thrust on one side only.
- The lower production cost of the blade and servomotor assembly.
- The lower power of the servomotor and therefore greater standardization of the various models.
- The possibility of using existing control systems almost in their entirety.

The units proposed for this application are not illustrated in detail, since they are completely identical to those illustrated for the steering means, the only difference being the zone where they are placed on board, and moreover small differences could be introduced for the shape of the blade, as well the ratio between the width and the length of the blade.